UNITED STATES PATENT OFFICE.

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COAL BRIQUET AND PROCESS OF FORMING THE SAME.

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To all whom it may concern:

Be it known that I, WARREN WILFORD LANGDON, a citizen of the United States, and a resident of Walla Walla, in the county of Walla Walla and State of Washington, have invented certain new and useful Improvements in Coal Briquets and Processes of Forming the Same, of which the following is a specification.

This invention relates to fuel briquets, and has for an object to provide a novel briquet as well as an improved process of producing the same, and the invention consists in the process and in the briquet as more fully described and claimed hereinafter.

The object of the invention is to produce a briquet which will hold its shape and remain solid when subjected to a high temperature, so that it will not disintegrate and fall to pieces when burning; will retain its shape and remain solid and unimpaired when exposed to the elements, stored in wet places, or otherwise subjected to moisture; and will be sufficiently hard and infrangible to prevent it from readily breaking up or chipping off when handled.

It has been found, through a long series of experiments, that briquets made with pitch alone as a binder have a tendency to fall to pieces while burning by reason of the heat melting the binder, and the efficiency of the briquet as a fuel is thus lost or impaired. Briquets so made, that is to say with pitch alone as a binder, are also too brittle and do not stand handling, although such briquets operate efficiently to resist exposure to moisture. On the other hand, it has been found that briquets made with a starch paste as a binder handle well, not being too brittle, and do not disintegrate under the influence of ordinary heat. Such briquets, however, thus made with a paste binder alone, disintegrate or deteriorate when exposed to the elements or otherwise subjected to moisture. It becomes therefore important to provide a method of producing a briquet and a briquet which will embody efficiently the merits of both forms of binder, and in doing this, it has been found necessary to devise a method whereby the two binders may be utilized in an efficient manner.

It has been found in all cases where pitch is used for a binder for briquets, that it is necessary, in order to secure the proper incorporation of the pitch with the coal so that it will act as an efficient binder, that the coal at the time of applying the pitch shall not contain more than 3% of moisture. If a greater amount of moisture is present, it will prevent the pitch from adhering to the coal particles. A greater amount of moisture than 3% in the coal will also prevent petroleum or other oil from adhering to the coal particles.

In the course of the experiments, it has developed that inferior results are secured if the paste is added to the finely divided coal prior to the incorporation therewith of the pitch, as the moisture in the paste in such instance prevents the pitch from readily combining with the finely divided coal in such manner as to secure the best results, as it will prevent the pitch from adhering intimately to the coal particles, and the moisture in the paste will also prevent the pitch from intimately adhering to the paste, the result being that the pitch is allowed to act neither as an efficient binder nor as a water-proofing for the coal or for the paste or for the briquet as a whole; and it is found that briquets made according to such plan, that is to say, wherein the paste is associated with the coal prior to the mixing therewith and incorporation therewith of the pitch, disintegrate and fall to pieces when exposed to moisture.

In some cases petroleum has been utilized and applied to the coal prior to the mixing therewith of the paste, but in such cases the moisture of the paste prevents the petroleum from properly forming a water-proofing for the paste itself, and so allows the paste to soften when the briquet is exposed to moisture. In such case the petroleum will also evaporate, run off, and otherwise waste from the surface of the briquet, leaving the surface subject to disintegration by moisture. The petroleum so applied has been used and acts, in so far as it has any efficiency, solely as a water-proofing, and does not form a binder for the briquet. It is, therefore, of service only to the extent of its efficiency as a water-proofing.

It has also been found that briquets made with a binder including pitch and dry flour are not sufficiently strong because the flour when thus used does not have sufficient binding power, as it should be boiled and applied while moist in order to secure the greatest efficiency.

By my invention, I seek to secure the desired results and to avoid the objections hereinbefore referred to, and in carrying out my process I employ in connection with finely divided coal, (in such term I would include coal slack, coal dust, coal pulverized practically to a powder, or coal in other finely divided forms), pitch in a pulverized form, and a paste, in the manner more fully described hereinafter. In the use of the term pitch I include coal tar, in forms that are solid at ordinary temperatures, water gas pitch, rosin, asphaltum, and any other solid resinous or bituminous substance. It has been found most practicable to use the pitch in pulverized form. It may, however, be used in melted or semi-fluid form or in any other shape in which it is possible to mix it thoroughly with finely divided coal. The paste is preferably a flour paste prepared in the ordinary manner commonly used by paper hangers and may be regarded as an ordinary paper hanger's paste. However, any glutinous or starch paste may be used. In making said paste, I may add thereto a strong alkali, such as ordinary lye or potash, for the purpose of preserving the paste and preventing it from mildewing or molding. I may also use an oil, preferably crude petroleum, in making my briquet, in the manner which I will now describe.

The proportions of the different elements may be varied, but it will be found practicable to use proportions substantially as follows. Thus when petroleum is used, I take, by weight, 3% of petroleum, 2% of pitch, 93% of finely divided coal, and 2% of paste. When petroleum is omitted, as it may be in some instances, I will use 3% of pitch, 2% of paste, and 95% of finely divided coal.

In mixing the different elements, the coal in finely divided form is first dried so as to contain in no case more than 3% of moisture, then the petroleum is added to the finely divided coal and is mixed so as in a measure to soak into or saturate the different particles of the coal. The pitch, in pulverized form, will then be added and thoroughly mixed with the saturated coal. Should pitch in melted form be used, the coal during the addition and mixing of the pitch therewith will have to be kept of sufficient temperature to keep the pitch in melted form. It may be said that the petroleum is useful because it increases the combustibility of the product, also limits the absorbing power of the coal so that it will take up less of the pitch, and in localities where the petroleum is cheap and the pitch comparatively expensive, it will doubtless be preferred to use the petroleum, although it may be omitted, in which case the percentage of pitch will be increased, as before described.

After the pitch has been added, the mass is subjected to heat in such manner as to melt the pitch and secure its intimate incorporation with the particles of the coal. Then, before the mass as cooled, the paste, while still hot as it is received from its boiler, is added to the mass and thoroughly mixed therewith, so that the mass will be bound together by both the pitch and the paste and the pitch will operate as a waterproofing envelop for the paste. The briquets are then produced by pressure in suitable molds while the mixture is still of such temperature that the pitch therein is in melted form, and it is preferred to heat these molds in order to secure a glazing or similar finish on the surface of the briquets. This glazing closes the pores and interstices which would otherwise appear on the surface of the briquet, thus making the briquet impervious to moisture, and the heat of the dies or molds will operate first to drive off the moisture of the immediate surface and thereby allow the pitch on the surface to become intimately incorporated with the paste, thereby, upon cooling, forming a waterproofing for the paste, the pitch also spreading under influence of the heated dies or molds uniformly over the surface to form a complete cover or envelop.

It may be stated that the use of the heated die operates to cook, preserve and cure the paste on and adjacent to the surface of the briquet, thereby preventing the growth of mold, mildew or other fungus when the briquet is stored for a long period in damp places.

The briquet produced by the described process differs from the ordinary briquet in that it consists of finely divided coal in which pitch is incorporated in such manner that the particles of the coal are enveloped and bound together by the pitch and the paste also unites the said pitch-enveloped particles. Thus it will be seen that the pitch in addition to enveloping the coal particles forms a binder for the entire mass, and the paste also forms a binder for the entire mass, so that the two binders coöperate in securing a stable briquet which will be resistant, by reason of the pitch, from disintegration by moisture, and will also be resistant, by reason of the paste, from disintegration under the influence of heat.

It should be understood that the finely divided coal must be dried prior to the addition of the oil and the pitch so that the coal at the time of the addition of the oil and pitch will contain less than 3% of moisture. The reason for this is that a greater amount

of moisture in the coal will prevent the oil and the pitch from adhering to the coal particles, and therefore the pitch will not, in such case, act as a binder between the coal particles.

In the mining of coal a considerable portion of the product is always pulverized. This proportion is increased by the amount of coal that slakes in the air when stored. In the case of some varieties of coal, this dust can be utilized as fuel, but with a great loss of heat units. With other coal, only the lump can be made use of, and all the fine stuff (below what is called pea coal) is waste and a loss, unless it can be bound together in such a way as to become an artificial lump coal, that is to say, unless it is made into briquets. Now, for a briquet to be a practical commodity, it is necessary that it be hard enough to stand, without breaking or crumbling, such handling as coal is ordinarly subjected to in being shipped, hauled and delivered to the consumer. It must also be unaffected by moisture, so that there will be no disintegration, softening, or erosion of the briquet when it is exposed to the elements or when it is stored in damp basements or even under water. Furthermore, it is most essential that the briquet should hold its shape and not disintegrate when it is subjected to the heat of a furnace and is being consumed in the fire; for, without this quality, the time, labor, and expense of manufacture were to no purpose, and the dust had better been fed directly to the fire without having gone through an intermediate briquet state.

It has heretofore been the common experience of those engaged in the briqueting of coal that the only practicable and successful binder for the manufacture of briquets was pitch. Now, it is found by all that a briquet in which pitch alone is the binding agent will necessarily disintegrate in the fire, on account of the fact that the heat of the fire melts the pitch and thereby leaves the briquet without a binder, for melted pitch has practically no binding qualities; and the briquet returns to its original form of finely divided coal. In such case no advantage has been gained in briqueting the coal. It has, therefore, been found absolutely necessary to utilize some other agent in conjunction with the pitch which will act as a binder when the pitch becomes melted and which will hold the briquet together until it is consumed. In the past, the means of accomplishing this result adopted by practically all plants in commercially successful operation has been to confine the briqueting operations to coking coal—that is to say, to bituminous coal. Such coal is briqueted with a pitch of sufficiently high melting point that, as soon as sufficient heat is applied to melt the pitch, it at the same time, by reason of the peculiar qualities of bituminous coal, causes the particles of coal to adhere together, forming one solid body,—in other words, the coal of the briquet begins to coke. On account of this very quality of bituminous coal which causes it to coke under heat, finely divided bituminous coal can be successfully handled and used as fuel without briqueting. For, whereas pulverized, non-coking coal is forced through the smokestack by the draft, unconsumed, or is dropped through the grates, bituminous coal begins immediately to coke on being thrown into the furnace, and is thereby held and consumed in the fire. The result is that all the coal mined from bituminous veins can be utilized as fuel, whereas at every mine of non-coking coal there is an enormous pile of pulverized coal which is generally considered as so much waste, as it cannot be held in a furnace so as to utilize its heat units, and it is often burned in the dump pile in order to get it out of the way. Furthermore, the majority of lignites have a greater tendency than other coals to slake in the air soon after being mined, making it necessary for the product of the mine to be handled at once, and at best there is an enormous waste from slaking.

From the foregoing it will be seen that the most profitable and useful field for briqueting should be with lignites, provided an economical binder were used which could hold the briquet together in the fire. That such a binder has not in the past been found, is attested by the fact that prominent engineers who are interested in and who contract for the building of briqueting plants assert that they are unable to make a commercially successful lignite briquet. One method which has been employed to overcome these difficulties has been to mix with the non-coking coal which it is desired to briquet a little bituminous coal, the mixture then being briqueted with a pitch binder. I understand this has met with some success in the briqueting of anthracite slack. However, it is often difficult to obtain bituminous coal in lignite fields, and I know of no case where this method has been successfully employed in the briqueting of lignite. In some cases clay has been added to non-coking coal, and in others lime and other like substances, the idea being to find some substance that will hold the briquet together when the heat has melted the pitch binder. One great objection to the addition of such substances is that they materially increase the percentage of ash and thereby decrease the desirability of the product. In so far as it is possible, nothing incombustible should be added to the coal. Flour, or flour paste or other starch, has been tried as a binder to take the place of

pitch; but, so far, starch binders have not been found successful, on account of the difficulty in securing, when such a binder is used, a briquet which is sufficiently hard, and one which will not soften and dissolve when subjected to moisture. Then there have been numerous attempts to use a combination of pitch and starch paste, the object being to secure a binder or combination of binders which will resist both moisture and heat. So far as I have been able to ascertain, none of these attempts have been successful for the reason that the wrong system and order of applying the binders were used.

Like oil, pitch, when melted, will not mix with water, nor will the melted pitch adhere to any wet surface. In my experimenting with both the lignite and bituminous coals of the Puget Sound country, I have found that, in order to secure a strong adhesion of the pitch to the coal, it is necessary to reduce the moisture of the coal to about three per cent.

In the course of my experiments, I have taken finely divided coal, or coal slack, dried it thoroughly, and then mixed paste with it in the usual manner employed in making paste-binder briquets. I then mixed into the mass a pitch in pulverized form, which pitch when used alone with the same coal makes a hard water-proof briquet. I used approximately 80 pounds of pitch to a ton of coal. I then heated the mass to sufficient temperature to melt the pitch, and, while still of this temperature, delivered the mass to the press and molded it into briquets. These briquets were harder on cooling than newly made paste-binder briquets. However, I found that they were far from water-proof. In fact, after they had cooled and dried so that they were hard enough to sustain the weight of an average man, they softened and went entirely to pieces in the course of half an hour on being placed in water at an ordinary temperature. On the other hand, a briquet made from the same coal using only pitch as a binder, using the same kind of pitch and the same proportion, 80 pounds to the ton, was found to be hard and unaffected by immersion in water.

What happened in the case of the briquet made with both paste and pitch as binders, as above described, was this: When I put the paste into the coal, practically all the particles of the coal received a thin coating of the paste. Now, when the pitch was added and melted, the paste was between the coal and the pitch, and prevented the pitch for uniting with the coal. Also, the moisture of the paste prevented the pitch from mixing with and adhering to the paste. The result was that in large measure the pitch remained a separate substance, not adhering to any of the other substances making up the mass; and, on examining the mass, the small, unattached globules of pitch could be plainly seen. Undoubtedly here and there the pitch found a dry enough surface to adhere to, and by reason of this, the briquet was stronger than one made with paste alone. When the briquet was molded and cooled, the globules of pitch hardened, still without adhering to the particles of coal, since the moisture still remained in the paste, and therefore the pitch acted neither as a binder for the briquet to any practical extent nor did it act as a waterproofing for the paste. Therefore, when the briquet was subjected to moisture, the paste dissolved and the briquet disintegrated. In view of the thorough resistance to moisture of the simple pitch-binder briquet made from the same coal, the speed with which this pitch-paste briquet disintegrated was astonishing. I then made a briquet in accordance with the process described in British patent to Danvers No. 897, March 11, 1875 (44—1). For this I proceeded as follows: I took 500 pounds of dry, finely divided, lignite of the same lot used in the other experiments mentioned above: 22.5 pounds of pitch; 3/4 of a gallon of coal-tar; and 5/4 pounds of dry flour; these being the proportions indicated in the specifications of the Danvers process. I then melted the pitch in the tar, and when the whole mass became fluid and was brought up to the boiling point and allowed to boil for a few minutes, I added the flour in its dry state and mixed it thoroughly in the boiling mass, so that it became thoroughly incorporated in the mass, forming a tar-pitch-paste. This hot mixture was then added to the 500 pounds of coal, and was thoroughly mixed therewith in a mixing machine heated sufficiently to maintain the temperature. Then the mass, while still hot, was delivered to and run through the press in the usual manner employed in making briquets. I also tried experiments varying the process by increasing the amount of pitch, and the amount of tar, and also the amount of flour, and changing the order of application.

In all my experiments with the Danvers process, I had great difficulty in securing even a fair briquet from the press, not more than 5% of the number coming out whole; whereas, in the case of the briquets made by my improved process at least 95% of the briquets come out of the press whole and perfect. I account for this by the fact that I have found in my experiments, and it is the experience of others engaged in the briqueting of coal, that, where as pitch or tar binder is used, it is necessary to add water to the mass just before delivering it to the press, in order to secure whole, hard briquets. This is accomplished in my process by the addition of the water-made paste

just before going to the press. While the addition of water is entirely contrary to the theory of the Danvers patent, yet, in order to obtain better briquets for further experimenting, I made the experiment of adding water to the Danvers mixture just before delivering it to the press, and I thereby obtained much improved briquets, and a much larger proportion came out whole.

The briquets obtained by the Danvers process, upon cooling, were fairly hard, so that they could be handled without breaking, and had the appearance of fair briquets. Moreover, they were water-proof. However, upon throwing these briquets into a boiler furnace with a moderately heavy draft, I discovered that the heat, as they began to burn, caused the binder to melt, and allowed the briquet to disintegrate and to return to the original form of finely divided coal. This was the case whether the briquets were made by strict adherence to the Danvers process, or by the addition of water as the mass went to the press, as above described. The reason for this is very plain. When paste is made by boiling flour or other starch in water and it is used as a bond between two solids, its greatest binding power is obtained by drying the water out of it, leaving the paste a solid, dry starch uniting the two other solids. The liquid constituent of the paste is eliminated. Now, when paste is made by boiling starch in tar instead of water, to secure the same final bond as that secured in the case of water-made paste, it would be necessary to find some means of driving off the tar from the mixture so as to leave the bond a solid starch instead of a plastic mixture of tar or pitch and starch. Of course, this cannot be done, and it is not intended to be done, in making a briquet by the Danvers process. On the contrary the paste obtained by the Danvers process is a tarry, plastic mass, composed of starch, tar, and pitch, so mixed together as to form one, composite substance. Granting that this is so made by the boiling and by the use of pitch that when cool it becomes a solid, and is such a binder as will make a hard, water-proof briquet, yet, since the hardening of the mixture is accomplished not by drying or in any other way driving off any fluid constituent, but simply by reducing the temperature, therefore, when such a binder is again raised to the temperature at which it was originally fluid when mixed with the coal, it will again become fluid; and where such a binder is used in making briquets, it will necessarily melt in the fire and allow the briquet to return to the form of coal slack. In the case of water-made paste, after it has hardened, water has to be added to it in order to dissolve it, as it has in itself no fluid constituent. In the case of the tar and pitch-made paste, the fluid constituent is present all the time, and as soon as the sufficient heat is applied, it immediately becomes liquid, being brought back to the exact state it was in when the ingredients were mixed together. Heat, on the other hand does not affect the water-made paste until it is consumed. In other words, a tar-made paste, or an oil-made paste, or a pitch-made paste, is merely a composite substance which becomes more or less solid when cold and becomes fluid when hot. Since the flour, tar, and pitch intimately combine, there is no opportunity for the flour, the pitch and the tar to act as binders independently of each other. It is one substance, which is water-proof, to be sure, but is subject to the influence of heat and melts in the fire.

It is evident that if we could at one and the same time utilize the qualities of both the simple pitch binder and of the simple starch-paste binder, we would secure a briquet which would be capable of resisting the disintegrating influences of both heat and moisture; and furthermore, we would be adding no material which would detract from the desirability of the fuel.

We have already noticed that when water-made paste is added to the coal first, the pitch is prevented from adhering to the paste-enveloped particles, and the pitch is left a separate and uncombined substance. Now, why not combine the dry coal and the pitch first, and by adding the paste later, leave it the uncombined, separate substance? This is the method pursued in the present invention: I first mix pulverized pitch into the dry, finely divided coal, then heat the mass, thereby melting the pitch, which at once spreads among the coal particles and adheres to the surfaces, the mixing continuing at the same time. I then mix into the mass a water-made paste, which, by reason of its moisture, is prevented from adhering to such of the surfaces of the particles of the coal as are covered with the melted pitch, and also from mixing in any way with the pitch. It is kept a separate and independent substance, except where it comes in contact with those surfaces or portions of surfaces which are not thoroughly coated with the melted pitch; to which surfaces or portions of surfaces it, of course, adheres. So I find in this mass, on examining it, instead of the pitch in small, separate, globules, the wet paste in small globules throughout the mass, held there as a separate substance, uncombined with the pitch. The mass is then delivered to the press and briqueted. As the material comes under the pressure of the molds, wherever pitch covered surfaces come together, the paste is crowded out, since its moisture prevents its mixing with the pitch, and said pitch-covered surfaces become united by the pitch.

The paste is thereby confined to such portions of the surfaces of the coal particles as are not pitch-covered and to the interstices between the coal particles. The manner in which the paste fills the interstices might be illustrated in this way: Suppose you take a quantity of lead shot and cover the surfaces with melted pitch. You then put in wet paste and press the mass together. The pitch repels the wet paste, and the surfaces of the shot, wherever they touch one another, become united by the pitch, while the paste is crowded into the spaces between the points of contact.

Returning to the briquets; as they leave the press, they begin to cool, and the pitch at once hardens. As soon as the pitch becomes a solid, it loses its quality by which it repelled the wet paste; and the paste, which is filling the interstices as an independent substance, at once takes hold of the surfaces covered with the now hardened pitch, with which it is surrounded, in addition to such surfaces as were not coated with pitch and to which it had already adhered. As the paste dries, the briquet is then firmly bound together both by the pitch and by the paste, each acting independently of the other. The result is—and I have proved this conclusively by my experiments—that I have a briquet which, by reason of the pitch binding the particles of coal together, is hard and water-proof and cannot be disintegrated by moisture; and which, at the same time, cannot be disintegrated by heat when it is in the fire for the reason that the coal particles are also bound together by a dry starch paste, which has bound together both pitch covered surfaces and also those surfaces which were not thoroughly coated with the pitch. Since this paste is unmixed with the pitch, it is unaffected by the melting of the pitch, and is found not to be dissolved thereby during the time the briquet is burning. Probably the greatest binding strength of the paste when the briquet is hot is between those portions of the coal surfaces which were not covered by the pitch. At any rate, it is found sufficient to hold the briquet together in the fire under the heaviest draft, whereas the briquets made by all the other processes mentioned with the same coal go to pieces under the same conditions.

It thus appears that the moisture in the paste, instead of having been a detriment, is the very agent needed, and acts, when the proper process is used, so as to enable one to secure two separate binders, acting independently of each other on the same particles. When the wrong system is used, as when the paste is put in first, the moisture prevents the pitch from acting as a binder at all, excepting as between such portions of the surfaces as are not wet with the paste, and this is not sufficient to secure either a hard briquet or one that will resist moisture. When my method is used, the moisture serves to allow both binders to act as binders independently of each other, so that I get the full benefit of the combined strength of the two binders when the briquet is handled and stored under ordinary conditions, making it specially hard and tough so that practically no briquets are broken up in handling; and in addition the pitch serves to hold the briquet together when subjected to severe exposure to moisture; and furthermore, after the pitch has become melted in the fire, the paste still continues to act as a binder for the briquet sufficiently strong to hold the briquet intact under the strongest draft and until it is completely consumed.

In conclusion I have found by my experiments that the briquets made by my process, aside from having the combined qualities of being both water-proof and free from disintegration in the fire, are harder and tougher and less brittle than the briquets made by the Danvers process, or than the briquets made with the simple pitch binder, or than the briquets made with the simple paste binder, or than briquets made with a combination of pitch and paste put together in any other way than by the process herein described. I have found them practicable to manufacture, while it is almost impossible to make whole briquets by the Danvers process, using the same press that is so successful with my process. Moreover, being able to cut down the required amount of pitch by the addition of a paste binder working in conjunction with the pitch, I secure a briquet which is much more desirable than a simple pitch briquet for domestic use on account of its being much less smoky and much cleaner than the simple pitch briquet, and one which gives no obnoxious smell of pitch, tar, or oil, either when stored or when burning; and I have a briquet which holds its shape no matter how hot the fire, how strong the draft, or how rough the treatment.

I claim:

1. The process of producing coal briquets which consists in drying finely divided coal so that it contains not more than 3% of moisture, then mixing said finely divided coal with an oil, then mixing therewith a pitch, then subjecting the mass to heat whereby to melt the pitch and intimately associate it with the finely divided coal, and subsequently adding and mixing with the mass a water-mixed paste, all substantially as described, whereby the pitch will operate as a binder in resistance to moisture, and the paste will operate as a binder both in conjunction with the pitch and also when the pitch has become softened by heat as the briquet burns, as and for the purposes set forth.

2. The process of producing coal briquets

which consists in drying finely divided coal so that it contains not more than 3% of moisture, then mixing said finely divided coal with a pitch, then subjecting the mass to heat whereby to melt the pitch and intimately associate it with the finely divided coal, and subsequently adding and mixing with the mass a water-mixed paste, all substantially as described, whereby the pitch will operate as a binder in resistance to moisture, and the paste will operate as a binder both in conjunction with the pitch and also when the pitch has become softened by heat as the briquet burns, as and for the purposes set forth.

3. A briquet consisting of finely divided coal with which an oil has been mixed, pitch incorporated with the coal particles, the latter being enveloped and united by the pitch, and water-mixed paste uniting the said enveloped particles, all substantially as and for the purposes set forth.

4. A briquet consisting of finely divided coal, pitch incorporated with the coal particles, the latter being enveloped and united by the pitch, and water-mixed paste uniting the said enveloped particles, all substantially as and for the purposes set forth.

5. A briquet consisting of finely divided coal, pitch incorporated with the coal particles, the latter being enveloped and united by the pitch, and water-mixed paste uniting the said enveloped particles, the said briquet having the pitch uniformly spread upon its outer surface forming a water-proof and mold-proof glaze, substantially as set forth.

WARREN WILFORD LANGDON.

Witnesses:
H. C. Bakes,
Emma Langdon.